MARYLAND HISTORICAL TRUST
DETERMINATION OF ELIGIBILITY FORM

NR Eligible: yes ___ no ___

Property Name: Piers 5 and 6 Inventory Number: B-4487

Address: East side of Inner Harbor, south of Pratt St. west of President St. Historic district: ___ yes X no

City: Baltimore Zip Code: 21202 County: Baltimore City

USGS Quadrangle(s): Baltimore East

Property Owner: Mayor and City Council, TPOB Pier 5 LLC Tax Account ID Number: not available

Tax Map Parcel Number(s): ___ Tax Map Number: 4

Project: Red Line Corridor Transit Study Agency: Mass Transit Administration

Agency Prepared By: John Milner Associates, Inc.

Preparer's Name: Katherine Larson Farnham Date Prepared: 1/27/2006

Documentation is presented in: MHT State Inventory Form (1992).

Preparer's Eligibility Recommendation: ___ Eligibility recommended X Eligibility not recommended

Criteria: ___A ___B ___C ___D Considerations: ___A ___B ___C ___D ___E ___F ___G

Complete if the property is a contributing or non-contributing resource to a NR district/property:

Name of the District/Property: ___

Inventory Number: ___ Eligible: ___ yes Listed: ___ yes

Site visit by MHT Staff ___ yes X no Name: ___ Date: ___

Description of Property and Justification: *(Please attach map and photo)*

Piers 5 and 6 are the two easternmost finger piers located in Baltimore's Inner Harbor. Pier 5 is west of Pier 6, and a modern bridge with roadway connects both piers to the west end of Eastern Ave. They are backfilled concrete bulkhead wharfs connected in a U-shape and extending south into the harbor from E. Pratt St. The piers' edges are of reinforced concrete, supported in places with with treated wood pylons and steel I-beams. An original granite block side wall is visible on the east side of Pier 6 and is a feature unique among the Inner Harbor piers, but other visible pier walls were originally built with concrete The decks of both piers have been surfaced with modern brick, granite, and concrete pavers. Pier 5 contains several buildings, including a modern restaurant and the relocated Seven Foot Knoll lighthouse, now a tourist attraction. Connolly's Seafood Restaurant, a prefabricated metal wharf building on the west side of Pier 5, was the only remaining pre-1950 structure on the pier when it was demolished at some point after 1992. Pier 6 now contains a modern concert pavilion with a tent roof.

These piers were originally built during the 1904-1910 municipal harbor improvements to replace older piers that had burned during the Great Baltimore Fire of 1904. They were designed by Baltimore's Harbor Engineer Oscar F. Lackey, and were originally trapezoidal in shape. They were built of 10-foot-diameter steel cylinders filled with concrete and were among the earliest examples of this type of reinforced concrete wharfing technology in the U.S. In 1984, their configuration was changed

MARYLAND HISTORICAL TRUST REVIEW

Eligibility recommended ___ **Eligibility not recommended** X

Criteria: ___A ___B ___C ___D **Considerations:** ___A ___B ___C ___D ___E ___F ___G

MHT Comments:

John Dankmyer / 7/26/06
Reviewer, Office of Preservation Services **Date**

[signature] 8/7/06
Reviewer, National Register Program **Date**

200601766

when the northern 2/3 of the gap between them was infilled to create a parking area as part of the Inner Harbor's redevelopment as a restaurant, shopping, hotel, and entertainment center.

While much of the original substructure of Piers 5 and 6 remains intact below the surface, many of the cylinders were destroyed in the 1984 reconfiguration. The engineering significance of the piers has been compromised to a great degree by this work, deterioration of original elements, and other changes, including the addition of the Eastern Avenue bridge in 1987, and the refacing of the southern portion of Pier 5. The original industrial harbor setting has largely vanished due to the demolition of old wharf buildings and slips, the construction of numerous modern hotel-restaurant-shopping-parking structures, and the importation of out-of-context historical vessels and the lighthouse mentioned previously. Pioers 5 and 6 today resemble a modern waterfront pedestrian mall and do not convey obvious historical or engineering significance of any kind. They are recommended not eligible for the NRHP.

MARYLAND HISTORICAL TRUST REVIEW

Eligibility recommended _____ **Eligibility not recommended** _____

Criteria: ___A ___B ___C ___D **Considerations:** ___A ___B ___C ___D ___E ___F ___G

MHT Comments:

_____ _____

Reviewer, Office of Preservation Services **Date**

_____ _____

Reviewer, National Register Program **Date**


Piers 5 & 6
Pratt St.
MIHP # B-4487
Baltimore East
BALTIMORE
Basin
Feils Point
Locust Pt
NORTHWEST HARBOR
Federal Hill Park
Riverside Park
Swann Park
Latrobe Park
Locust Point Marine Terminal
Patterson Park
Hampstead Hill Jr. High Sch
St Alphonsus Cemetery
St Katharines Convent
Johns Hopkins Hospital
Holy Rosary Sch
Armory
Library
Light
30 FEET NOV 1941
WESTERN MARYLAND
B & O
McCOMAS


4

B-4487
Piers 5 & 6, Pratt St.
Baltimore City, MD
Sarah Traum
12/14/2005
MD SHPO
View of Piers 5 (L) + 6 (R) from pumping station, to NW
#1 of 4

B-4487
Piers 5 & 6, Pratt St.
Baltimore City, MD
Sarah Traum
12/14/2005
MD SHPO
View to SW of Pier 5
#2 of 4

191

B-4487
Piers 5 + 6, Pratt St.
Baltimore City, MD
Sarah Traum
12/14/2005
MD SHPO
View to SE of Pier 6
#3 of 4

187

B-4487
Piers 5 + 6, Pratt St.
Baltimore City, MD
Sarah Traum
12/14/2005
MD SHPO
View to SW of Pier 6 showing granite bulkhead
#4 of 4

Survey No. B-4487
Piers 5 and 6
Baltimore City

HISTORIC CONTEXT

MARYLAND COMPREHENSIVE HISTORIC PRESERVATION PLAN DATA

Geographic Organization:	Piedmont (Baltimore City)
Chronological/Developmental Period(s):	Industrial/Urban Dominance (A.D. 1870-1930) Modern Dominance (A.D. 1930-Present)
Prehistoric/Historic Period Theme(s):	Transportation; Engineering, Community Planning
Resource Type:	
Category:	Structure
Historic Environment:	Urban waterfront
Historic Function(s) and Use(s):	Pier/bulkhead
Known Design Source:	Oscar F. Lackey

MARYLAND INVENTORY OF HISTORIC PROPERTIES

Survey No. B-4487

Magi No.

DOE __yes __no

Maryland Historical Trust State Historic Sites Inventory Form

1. Name (indicate preferred name)

historic Piers 5 and 6

and/or common N/A

2. Location

street & number East Pratt Street west of Jones Falls in the Inner Harbor **not for publication**

city, town Baltimore City ___ **vicinity of** **congressional district** Third

state Maryland **county** N/A

3. Classification

Category	Ownership	Status	Present Use	
___ district	___ public	_X_ occupied	___ agriculture	___ museum
___ building(s)	___ private	___ unoccupied	_X_ commercial	___ park
___ structure	___ both	___ work in progress	___ educational	___ private residence
___ site	**Public Acquisition**	**Accessible**	_X_ entertainment	___ religious
_X_ object	___ in process	___ yes: restricted	___ government	___ scientific
	___ being considered	_X_ yes: unrestricted	___ industrial	_X_ transportation
	___ not applicable	___ no	___ military	___ other:

4. Owner of Property (give names and mailing addresses of all owners)

name City of Baltimore c/o Baltimore Development Corporation

street & number 36 S. Charles Street, Suite 1600 **telephone no.:** 410-837-9305

city, town Baltimore **state and zip code** Maryland 21201

5. Location of Legal Description

courthouse, registry of deeds, etc. Circuit Court of Baltimore City **liber** S.E.B.

street & number 100 North Calvert Street **folio** 3011

city, town Baltimore **state** Maryland

6. Representation in Existing Historical Surveys

title N/A

date ___ **federal** ___ **state** ___ **county** ___ **local**

depository for survey records

city, town **state**

7. Description

Survey No. B-4487

Condition		Check one	Check one
___ excellent	_X_ deteriorated	___ unaltered	_X_ original site
___ good	___ ruins	_X_ altered	___ moved date of move _____
___ fair	___ unexposed		

Prepare both a summary paragraph and a general description of the resource and its various elements as it exists today.

SUMMARY DESCRIPTION

Piers 5 and 6 are solid piers consisting of back-filled concrete bulkheads extending from East Pratt Street south into the Baltimore Inner Harbor west of the Jones Falls outlet. Now one structure U-shaped in plan, the piers were originally two parallel trapezoids. There have been two major alterations to the piers. In 1984, the space between the northern two/thirds of the piers was infilled. This reconfiguration affects the integrity of the overall form of the piers, particularly the character-defining lumber slips on Pier 6 that are now gone. The reconfiguration does not affect the integrity of remaining sections of the bulkheads. The original structure is still present, although its condition is deteriorated. In the late 1980s, the bulkheads at the southern end of Pier 5 were rebuilt in conjunction with the construction of Harrison's, destroying the integrity of the bulkheads in this location.

DESCRIPTION

Piers 5 and 6, which have been joined together since 1984, are part of a 1904-1910 harbor improvement that originally consisted of 6 trapezoidal piers extending south into the Inner Harbor between Light Street and Jones Falls. The piers are located between Market Space and Jones Falls. Pier 6 is the easternmost pier of the group; Jones Falls empties on its eastern side. Pier 5 is west of Pier 6. The immediate visual context for the piers is relatively intact. The surrounding urban area is comprised of structures constructed from the early to late 20th century. Pier 4, to the west of Pier 5, and several prominent early 20th century buildings that form the visual boundaries of the piers are still present. Most of Piers 5 and 6 are used for surface parking. There is a late 20th century music pavilion at the foot of Pier 6 and a late 1980s hotel and restaurant complex at the foot of Pier 5. Connolly's Seafood Restaurant, a complex consisting of prefabricated metal buildings, at the west end of the head of Pier 5, is the only remaining structure that dates from the first half of the 20th century.

The original construction of the piers is depicted in engineering drawings. The following description appeared in 1909 in *The Engineer*, a British publication:

> The face structures consist of series of steel cylinders, filled with concrete, connected by reinforced concrete sheet piling, and the superstructures are of reinforced concrete or masonry. The cylinders are 10 ft. in diameter, and built of 3/8 in. steel plate, stiffened by 3 in. by 3 in. by 3/8 inch angles. They are sunk to a depth of 27 ft. below low water and spaced 25 ft. centres. . . .
>
> In the typical section the floor is carried by two 15 in. -- 45 lb. per foot -- steel channels on the face of the cylinder, and a 4 in. thick reinforced concrete wall in the rear, the wall resting directly on the top of the sheet piling. The latter is of reinforced concrete, gauged in the proportions of 1 cement, 2 sand, and 4 crushed stone or gravel. The piles are 18 in. wide by 12 in. thick, with four 3/4 in. steel bars in tension and four 3/8 in. square bars in compression. The longitudinal reinforcement is connected by 5/16 in. round steel hoops placed 18 in. apart. On the water side the reinforcement is covered by 2 in. thickness of concrete. The outward thrust of the

8. Significance

Survey No. B-4487

Period	Areas of Significance—Check and justify below			
___ prehistoric	___ archeology-prehistoric	X community planning	___ landscape architecture	___ religion
___ 1400–1499	___ archeology-historic	___ conservation	___ law	___ science
___ 1500–1599	___ agriculture	___ economics	___ literature	___ sculpture
___ 1600–1699	___ architecture	___ education	___ military	___ social/ humanitarian
___ 1700–1799	___ art	X engineering	___ music	___ theater
___ 1800–1899	___ commerce	___ exploration/settlement	___ philosophy	X transportation
X 1900–	___ communications	___ industry	___ politics/government	___ other (specify)
		___ invention		

Specific dates **Builder/Architect**

check: Applicable Criteria: __A __B X C __D
and/or
Applicable Exception: __A __B __C __D __E __F __G

Level of Significance: X national __state __local

Prepare both a summary paragraph of significance and a general statement of history and support.

STATEMENT OF SIGNIFICANCE

Along with Pier 4, Piers 5 and 6 in the Baltimore Inner Harbor were among the first concrete piers constructed in seawater in the United States. Constructed from 1908 - 1910, these and other early concrete piers in the U.S. played an important part in the acceptance of reinforced concrete for American harbor construction. Designed by Oscar F. Lackey, Harbor Engineer for Baltimore, Piers 5 and 6 meet National Register Criterion C because they embody the distinctive characteristics of a method of construction. The solid piers, consisting of filled bulkheads, were important in the evolution from timber pile to reinforced concrete for seawater construction.

HISTORY

The piers in the Inner Harbor were built on the site of earlier piers that the devastating fire of February 1904 had reduced to rubble. Along with the piers, the fire destroyed much of downtown Baltimore. Thus the Burnt District Commission, formed to oversee the rebuilding of the city, had the power to condemn property for street-widening and to establish new building codes. Exercising this authority, the Commission condemned property extending into the Inner Harbor shifting the former privately owned piers to municipal control. The Harbor Board rebuilt the piers under the authority of Ordinance No. 149, November 10, 1904.[1] Pier 5 cost $385,864.97, $264,133.34 of which was for land acquisition; Pier 6 cost $1,477,220.06, $951,363.76 of which was for land. Each pier had a load limit of 1000 lbs. per sq. ft.[2]

Work on the harbor lagged behind the reconstruction of downtown first because of problems with the condemnation proceedings and then with delays in the timber pile construction for Piers 1, 2, and 3. The old piers had been thickly settled with houses and commercial enterprises prior to the fire.[3] Property owners on the former piers contested valuations to stall the condemnation because they feared that municipal leasing procedures could deprive them of access to the water that ownership had provided. Timber pile construction proceeded slowly because the work could only take place at low tide and the contractor refused to put on extra crews.

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[1] *Harbor Board Report for 1904*, p. 1.

[2] Harbor Board of Baltimore, *Survey of the Port of Baltimore*, Vol. 1, pp. 24-27.

[3] Barbara K. Weeks, *An Archival Investigation of the Archaeological Resources Associated with Harrison's at Piers 5 and 6, Baltimore, Maryland*," pp. 13-19.

9. Major Bibliographical References

Survey No. B-4487

Please see Continuation Sheets

10. Geographical Data

Acreage of nominated property approx. 9 acres

Quadrangle name Baltimore East **Quadrangle scale** 1:24000

UTM **References** do NOT complete UTM references

	Zone	Easting	Northing		Zone	Easting	Northing
A				B			
C				D			
E				F			
G				H			

Verbal boundary description and justification

City Blocks 684-D (Pier 5) and 684-E (Pier 6) correspond with the historical configuration of the piers.

List all states and counties for properties overlapping state or county boundaries

state	N/A	**code**	**county**	**code**
state	N/A	**code**	**county**	**code**

11. Form Prepared By

name/title Betty Bird

organization **date** July 29, 1992

street & number 2025 Eye Street, N.W., Suite 801 **telephone** 202-463-2033

city or town Washington, D.C. 20006 **state** N/A

The Maryland Historic Sites Inventory was officially created by an Act of the Maryland Legislature to be found in the Annotated Code of Maryland, Article 41, Section 181 KA, 1974 supplement.

The survey and inventory are being prepared for information and record purposes only and do not constitute any infringement of individual property rights.

return to: Maryland Historical Trust
Shaw House
21 State Circle
Annapolis, Maryland 21401
(301) 269-2438

> sheet piling at the top is taken by a steel lattice girder, embedded in concrete, placed at a distance of 4 ft. to 5 ft. behind the face line of the pier. The girder, which is 2 ft. 6 in. deep horizontally, consists of four 6 in. by 6 in. by 7/8 in. angles double braced with 3 in. by 1/2 in. flat bars spaced 14 in. centres. The cylinders are tied back to anchor beams and piles by means of eight 1-1/8 in. square steel bars to each cylinder, or 25 ft. apart centre to centre of tie clusters. The tie bars are embedded in concrete measuring 18 in. by 10 in. in section. The anchor beam is 28 ft. back from the face line of the pier, and consists of concrete 3 ft. deep and 15 in. thick, reinforced by eight 1-1/4 in. square bars. The anchor beam rests on and is tied to two 15 in. diameter reinforced concrete piles abreast of each cylinder.
>
> In the Jones' Falls walls . . . a reinforced concrete beam is substituted for the lattice girder. This beam is 2 ft. 2 in. by 2 ft. 6 in. with six lin. square bars to take the lateral thrust, and five 7/8 in. square bars to sustain the vertical load. The concrete mixture is the same as in the sheet piling. On top of the reinforced beam a rubble masonry wall is constructed.[1]

Pier 5 was originally 1058.5 ft. long on the west and approximately 1300 ft. long on the east. The head of Pier 5 prior to the 1984 alterations was 205 ft. wide. Beginning 680 ft. from Pratt Street, the pier flaired out to the east so that the southern half was wider than the northern half. Pier 6 was originally approximately 1400 ft. long on the west and 1542 ft. long on the east. While their basic structural system is the same, Pier 6 incorporated several features that distinguished it from other Inner Harbor piers. The concrete bulkheads on the east side of Pier 6 facing the Jones Falls outlet were faced with granite rather than reinforced concrete. Moreover, the western side of Pier 6 consisted of projecting slips that created a sawtooth edge in plan. Diagonal projections formed 20 ft. wide slips, each slip between 200 and 250 ft. long. Recent infill between Piers 5 and 6 has obliterated this distinguishing characteristic.

The bulkheads are presently in deteriorated condition. Several engineering studies conducted over the past 20 years have documented the condition of this resource. A 1973 feasibility study by Whitman, Requardt and Associates assessed the condition of Piers 5 and 6. Whitman Requardt found deterioration that was particularly severe toward the southern ends of the pier, which had been subjected to the greatest turbulence. Steel jackets encasing the cylinders had eroded and cylinders were disintegrating. The top portions of many of the cylinders were missing and remaining cylinders had holes. The beam at the face of the pier was damaged in several places. Concrete sheet piling was in "poor condition" and had shifted in several locations creating voids behind the sheeting. The timber fender system was still present, in good repair only in areas of use. In describing the condition of Pier 4, which also prevailed in Piers 5 and 6, Whitman, Requardt wrote,

> In general the concrete used for the beams, girders, and cylinders is of very poor quality. Pieces can be easily removed or chipped away. Examination of such pieces

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[1] "New Harbour Works at Baltimore," *The Engineer*, January 29, 1909, pp. 105-107.

reveals that there was insufficient cement paste to completely fill the voids in the aggregate. In addition such pieces can be easily crumbled by hand.[2]

Similar conditions were found on Pier 6. The facing beam on the west side of Pier 6 was in disrepair with concrete broken and steel reinforcement exposed. Steel casings for the cylinders had rusted away and concrete had spalled. Settlement and voids were evident behind the sheeting and the timber fender system on the west side of the pier was virtually gone. On the east side of the pier, the stone bulkhead was in good condition and the timber fender was still visible.[3]

The most recent study of Pier 6 conducted by M.G. McLaren, P.C. in September 1990 found that the granite bulkhead was in "fair" condition with the tidal zone exhibiting the most damage. Steel jackets encasing the concrete cylinders were missing. The top 5 ft. of the concrete was exposed and the concrete had spalled from 1" to 6" within the tidal zone. Reinforcing steel was exposed on over 20% of the beam, which was spalled along 90% of its length. The concrete sheeting exhibited corner spalls and gaps at the mud line and between the closure sheet and the concrete cylinder. Fill had eroded behind the sheeting. The remains of the timber fender system were visible, but the piles had deteriorated below the water surface. The granite block retaining wall was in good condition with the exception of loose or missing capstones.[4]

The same study found that the concrete bulkheads on the south and west sides of Pier 6 were severely deteriorated or had failed. The worst conditions were found at the southern 150 ft of the west side where the bulkhead had collapsed. The concrete cylinders were missing their steel jackets and were disintegrating, with their top portions either missing or having holes. Aggregate could be removed by hand. The reinforcing steel within the facing beam, which was broken along most of its length, was exposed. Sheeting behind the beams was displaced. Grout used to repair the cylinders on the west side had lost structural integrity. There were gaps between the sheeting bays and between the sheeting and the cylinders. Fill was leaking from between the gaps, which in some cases exceeded 8" in width. The subsidence of fill had created two severe voids on Pier 6. Stubs of the fender system were still visible at or below the water line.[5]

Nevertheless, for the most part the basic structural system of Piers 5 and 6 remains despite isolated failures and serious deterioration. The physical appearance of the piers has changed more than their structure. Historic photographs and Sanborn maps depict warehouse structures along the western and southern side of Pier 5. Photographs show stacks of lumber on Pier 6. Of the structures depicted in the maps and photographs only Connolly's Seafood Restaurant, at the northwest corner of Pier 5 remains. The most extensive changes to the pier took place in 1984 when the northern 2/3 of Piers 5 and 6 were joined to form a parking area.[6] The infill destroyed the distinctive configuration of the western edge of Pier 6. Further changes took place when Harrison's was built in the late 1980s. Construction of a relieving platform involved "partial demolition, abandonment and replacement of the

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[2]Whitman, Requardt and Associates, "Engineering Feasibility Report: Inner Harbor East," p. I-3.
[3]*Ibid.*, pp. I-3 - I-5.
[4]M.G. McLaren, P.C. "Pier 6 Bulkhead Inspection," pp. 2-3.
[5]*Ibid.*, pp. 4-5.
[6]Rummel, Klepper & Kahl, "Engineering Feasibility Analysis," p. ii.

southern portions of the Pier 5 bulkheads." A new pier face was built approximately 3.5 ft. in front of the original face and a steel sheet pile bulkhead was inserted approximately 16 ft. behind the original concrete sheet pile.[7] The construction of the Eastern Avenue bridge in 1987 also affected the bulkheads but only in the immediate vicinity of the bridge on the east side of Pier 6.[8] Thus the structure of the bulkheads still remains along most of Pier 6 and along the northern end of the west side of Pier 5.

[7] *Ibid.*, p. III-4.
[8] *Ibid.*, p. III-2.

In 1905 Oscar F. Lackey (1874-1928) joined the Harbor Board. Lackey was born in Washington, D.C. but grew up in Baltimore, graduating from Johns Hopkins with a degree in civil engineering in 1896. He joined the War Department as an engineer and in 1897 was sent to Santiago, Chile to work under General Leonard Wood. After a bout of yellow fever, he designed docks in Cuba and then went to Panama to work on construction of the Panama Canal. In 1906 he returned to Baltimore as the Principal Assistant to N.H. Hutton, the Chief Engineer and President of the Harbor Board. When Hutton died shortly thereafter, Lackey succeeded him as Chief Engineer, a position he held until he left the Harbor Board in 1915 to join Poole Engineering. During this period Lackey served as one of five directors of the Association of Seaport Authorities and as president of the Association of Port Authorities.

In 1918 Lackey was appointed Supervising Engineer in the War Department. His responsibilities included construction of port terminals in Boston, Philadelphia, Brooklyn, Norfolk, New Orleans, and Charleston. In 1921 he returned to Cuba as a consulting engineer and after returning to the United States served as a consulting engineer on several harbor projects. From 1924 to 1927 he was head of the Transportation Bureau of Baltimore and shortly before his death in 1928 he was appointed Chairman of the State Roads Commission of Maryland to review plans for the proposed Bay Bridge.[4]

Because of his international experience and particularly his work on the Panama Canal, Lackey possessed a vision of the harbor facilities Baltimore required to be competitive during the 20th century. Lackey advocated municipal ownership of all harbor facilities as early as 1908, pressing for a $50 million loan for harbor improvements.[5]

While construction of Piers 1, 2, and 3 had employed traditional methods and materials, Piers 4, 5, and 6 were of reinforced concrete construction. The use of reinforced concrete for seawater construction was highly controversial as late as 1915. Lackey is credited with being among the first in the United States to employ this method. His obituary stated that, "he was one of the first, if not the first, engineer to utilize reinforced concrete piles in pier construction."[6] In his extensive world-wide study of reinforced concrete docks undertaken in 1915, Harrison S. Taft could not determine which was the first complete reinforced concrete dock in the U.S.

> A study of the constructive dates of concrete pile or concrete column docks would indicate that such types began about 1905 or 1906. Still, it is not evident which was the first of such docks to come into existence, the whole development being a gradual evolution from a concrete-filled steel cylinder column, steel deck-beams, and concrete-slab type, as used in the Philippines by the United States Government in 1902.
>
> Irrespective of the actual beginning of constructing reinforced concrete docks, it is generally conceded that Oscar F. Lackey, M. Am. Soc. C.E., Harbor Engineer of

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[4]Ezra B. Whitman, "Memoir of Oscar Francis Lackey, M. Am. Soc. C. E." in *Transactions of the American Society of Civil Engineers* Vol 93, pp. 1863-1864; Obituary, *Baltimore Sun*, December 20, 1928.
[5]*Harbor Board Report for 1908; Harbor Board Report for 1910*, p.33.
[6]Whitman, p. 1863.

> Baltimore, was among the first, if not the first, to blaze the way for the extensive use of reinforced concrete in dock construction in United States harbors.[7]

Because of their early date, Piers 4, 5, and 6 played an important part in the evolution from traditional pile and timber construction to reinforced concrete. At the turn of the century, mathematical analysis of structures and the study of strength of materials were based on empirical experience. Engineering practice was thus strongly biased in favor of traditional approaches. Without compelling reasons to innovate, the success and endurance of structures that had worked in the past constituted a powerful argument for their continuation. While concrete had been used successfully in bridge caissons and other construction work in fresh water rivers and lakes, its use in seawater posed serious problems. American engineers had little experience using concrete in brackish water. Salt water affected both the strength and the durability of the material. In his 1915 survey, Taft found that "in the United States the construction of reinforced concrete docks is in a very embryonic state, and the use of cement in structures standing in sea water, on the part of American engineers, has not always been successful. On the other hand, concrete has been used successfully for more than 50 years in Europe for structures exposed to the action of salt water, and English engineers have been building reinforced concrete docks for about 20 years."[8]

Deforestation provided the incentive for European engineers to devise alternatives to timber docks and to address the problem of concrete and seawater. Concrete's wide use in European ports gave European engineers a familiarity with the material and its limitations that encouraged the development of reinforced concrete harbor construction. In the United States, where timber was both plentiful and cheap, concrete was seldom used and there was little justification to understand the material.[9]

Timber offered numerous advantages that discouraged innovation, not the least of which was its low initial cost. Pile and timber construction produced a flexible structure that could easily absorb the shocks and poundings inherent in docking boats and barges. Because timber construction consisted of discrete elements, it could be easily modified and components replaced and repaired without affecting the entire structure. While timber piers usually lasted about 15 years,[10] this short life span was advantageous since harbors continually changed to meet new requirements of ever larger ships.[11]

Nevertheless, timber construction had shortcomings that were to become increasingly problematic. Pile and timber docks required constant ongoing maintenance and repair. The teredo worm and other marine borers that attacked wood constituted a potentially devastating menace. Once confined to tropical waters, the index to the *Transactions of the American Society of Civil Engineers* show that they had become an acknowledged problem in the United States by the 1890s. The filth present from dumping city waste and sewerage in 19th century harbors checked the teredo in most northern U.S. ports. However, as municipal sewage systems were established and harbors cleaned up, the teredo

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[7]Harrison S. Taft, Esq., "Reinforced Concrete Docks: Foreign and American Structures. Failures, Costs, and General Considerations," in *Transactions of the American Society of Civil Engineers* (1915), p. 1096.

[8]Taft, p. 1058.

[9]Taft, p. 1060.

[10]Taft, p. 1110.

[11]W.J. Barney, Discussion of timber vs. concrete piers, *Transactions of the American Society of Civil Engineers* (1915), p. 1113.

multiplied. By the second decade of the 20th century, the teredo had been found in Atlantic ports up and down the east coast. So destructive was this worm that it could cut through large timber piles in only a few months.[12] The switch from coal to fuel oil for steamships constituted an additional problem because of the danger from fire caused by frequent oil spills.[13]

Beyond inherent conservatism within the American engineering profession that maintained its preference for timber docks, concrete as a material had numerous shortcomings. Widespread, well-publicized failures in the United States and its territories had discouraged its use. In seawater, concrete was subject to a host of problems. Salt increases corrosion causing steel reinforcing to rust and fail and the reinforced concrete to lose its integrity and to disintegrate. Any permeability in the material permits corrosion to attack the steel. Freeze-thaw cycles especially threatened the integrity of the material. The rigidity of concrete posed another drawback. While timber structures could accommodate shocks from collisions, concrete structures required fender systems to absorb blows. To protect the integrity of material, docks required monolithic structural design. While this approach reduced the number of joints, it further intensified the rigidity of the structure. An additional difficulty in the acceptance of concrete in the United States was that the best construction systems required patented features forbidden by municipal bidding regulations.[14]

Because of the controversy surrounding the use of concrete in seawater and the lack of experience with it in the United States, Piers 5 and 6 played an important role in demonstrating that the material could be used with success and in providing cost data that helped establish an economic rationale for using concrete in other situations. The 1913 Annual Report of the Harbor Board recalled that "plans for the first concrete piers ever constructed in this country, after a hard fight on the part of the Harbor Board, were approved."[15] In their 1907 Annual Report, the Harbor Board cited the following reasons for using concrete for Piers 4, 5, and 6:

> the Harbor Board has adopted the use of concrete and steel for construction of Piers 4, 5 and 6 in preference to that of pile and timber for several reasons:
>
> 1st. It is cheaper
> 2nd It is more durable, stronger and better suited to the conditions of the harbor, and it is permanent.
> 3rd The work can be carried on without any great interference by tides, which has been the main cause of delay in the construction of Piers 1, 2 and 3.
> 4th The piers present a better appearance.
> 5th The cost of maintenance is very materially decreased.
> 6th Provision is made, for those desiring, for the erection of sheds either of steel or of timber.

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[12]Eugene W. Stern, Discussion of concrete as material for piers, *Transactions of the American Society of Civil Engineers* (1915), p. 1115.

[13]Taft, p. 1068.

[14]Charles W. Staniford, "Modern Pier Construction in New York Harbor" in *Transactions of the American Society of Civil Engineers* (1914), p.563.

[15]*Harbor Board Report for 1913*, p. 68.

> 7th We feel that as the water of the harbor becomes less polluted, due to the diversion of sewerage now emptying into same, such sewerage being taken up by the new sewerage system, that the "teredo," a most destructive worm, will make its appearance. This has happened in other ports under similar conditions. This worm, which eats its way into the timbers, chiefly between the M.L. and M.H. water lines, can be found as far up as Sparrows Point. At Annapolis all piles are protected by concrete or otherwise against the "teredo," which doubles the cost of construction. For this reason, if for no other, this Board does not think it advisable to put out a great amount of money for the construction of piers, which in all likelihood will in the course of a few years require a large additional expenditure to make them safe.[16]

The teredo had been present in Annapolis since 1886 and in Norfolk since the Civil War. The worm had travelled up the Chesapeake Bay as far as Bear Creek prior to the reconstruction of the Inner Harbor. The likelihood of the teredo appearing in Baltimore was controversial. In addition to the sewerage pollution, many maintained that the Inner Harbor was not brackish enough and that the amount of oil in the upper harbor would discourage the worm's spread.[17] However, in 1914 the Harbor Board was vindicated. When old piers constructed in the 1870s were removed from the location of the Commercial Pier at Broadway, timbers were found "riddled by the teredo." The Harbor Board concluded, with some satisfaction, that this damage demonstrated that the teredo had been active in Baltimore Harbor prior to the extensive pollution of the late 19th century and that the worm would reappear when the sewerage problem was abated.[18]

Oscar F. Lackey and engineers at the Harbor Board designed Piers 4, 5, and 6. Like other early concrete docks in the U.S., the basic form of the Baltimore piers appears to be derived from the Navy Department's 1902 design for docks in Manila.[19] During 1908, the Harbor Board produced 102 plans, 76 tracings, and 478 blue prints, "principally ... details of the pier construction."[20] The Board opened bids in 1908 and awarded the construction contract to Sanford and Brooks of Baltimore.[21] Sanford and Brooks subcontracted work on the steel caissons to the Maryland Steel Company, which in turn subcontracted with the Snare & Triest Company and Bernard Rolf of New York. Concrete work was subcontracted to Raymond Concrete Pile Company, also of New York. Penniman and Browne, Chemists tested cement; Stulen Company of Harrisburg tested the steel.[22] The City Engineer's Department, compensated by the Harbor Board, paved the piers. Piers 4 and 5 were paved with belgian block on a 6 in. concrete base with tar filler. Pier 6, designed specifically as a lumber pier was paved with vitrified brick block on a 6 in. concrete base with concrete filler.[23]

The method of construction adopted represented a shift from the original design of the piers in the bidding specifications. Because the power house on Pier 4 survived the 1904 fire, it was imperative

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[16]*Harbor Board Report for 1907*, pp. 16-17.
[17]*Harbor Board Report for 1908*, pp. 27-28.
[18]*Harbor Board Report for 1914*, pp. 29-30.
[19]Taft, p. 1077.
[20]*Harbor Board Report for 1908*, p. 30.
[21]*Harbor Board Report for 1908*, pp. 19 and 20.
[22]*Harbor Board Report for 1908*, p. 24.
[23]*Harbor Board Report for 1909*, pp. 14-16.

that there be minimal disruption of conduit and other connections between the power house and the rest of the city. Neither the location of conduit or pipes was known with any precision. Accordingly, tie piles were located immediately back of the cylinders instead of a fixed distance equidistant behind them. Steel rods covered with three inches of concrete then replaced channel ties. Concrete sheet piling could then be driven behind the cylinders without requiring special piling at the location of the channel ties. This simplification, which resulted in both a reduction in cost and more rapid construction, was adopted for the two subsequent piers as well.[24]

The most detailed description of the construction of the piers can be found in a description of Pier 4, the first to be constructed:

> steel cylinders, with a cross section 3 feet by 10 feet and 27 feet long, were first driven in 4 foot sections, held together by angles, with additional angles running longitudinally from top to bottom, to prevent collasping (sic) from water pressure. These cylinders are placed every 25 feet on centers. After these cylinders were set in place, held by wooden frames, and allowed to settle from their own weight of 7 tons; the material in the interior of the cylinders was removed about two feet below the cutting edge of the cylinder, by a centrifugal pump. The cylinders were then driven to refusal, pumped again, and then driven to the final penetration, and filled with a mixture of 1-3-5 concrete. After the cylinders were driven, lattice girders built of 6 inches, by 6 inch by 7/8 inch angles were anchored from cylinder to cylinder and wrapped with wire fabric, and covered with about 3 inches of concrete to protect the steel, after which reinforced concrete sheet piles 12" by 18", weighing about three tons were driven behind the girders. [Sheet piles were 27 ft. long.[25]] After the sheet piles were driven, two 15 inch channels carrying the front of the wall, and guard rail were placed, and anchored to the cylinders, and covered with wire fabric and concrete. On top of the sheet piling was built a 6 inch reinforced concrete wall, which forms the back support for the 6 inch wall. The ties were placed two above, and two below, at each end of the lattice girder, and then bent over the outer face. They were then tied into a concrete beam reinforced with 9 7-8" bars, and the beam was carried on to form a concrete deadman, and two tie piles placed 30 feet from the wall in virgin ground 6 feet below the finished grade.[26]

The cylinders were preassembled off site and brought to the site in one piece. Sheet piling was cast on site and seasoned for 28 days.[27]

Taft described the completed piers as follows:

> It is perhaps at Baltimore that the most extensive reinforced concrete docks on the Atlantic seaboard have been built. Although the water in Baltimore Harbor may not

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[24]*Harbor Board Report for 1908*, p. 21.
[25]*Harbor Board Report for 1914*, p. 26.
[26]Harbor Board of Baltimore, *Survey of the Port of Baltimore*, November 15, 1920, pp. 18-19.
[27]*Report of Harbor Board for 1908*, p. 23.

> have the same density of salt as in ports nearer the sea, these docks, thus far, have shown no sign of deterioration, though at times subject to frost action....
>
> In general, these three [Piers 4, 5, and 6] docks consist of a series of oval-shaped concrete cylinders 25 ft. apart along the face of the docks, and sunk to about 25 ft. below low water. Along the face of the cylinders, and just above high water, there is a concrete-encased iron girder, tied back to a deadman some 28 ft. in the rear of each cylinder. A row of concrete sheet piling was driven back of the girders to form a vertical retaining wall, the upper ends of the sheet-piling bearing against the girder and the lower ends being driven into the muddy bottom. A horizontal box-girder encased in concrete runs along the upper face of the dock, supporting the outer edge of the concrete curb slab, on which are laid the paving blocks. The cylinders are tied together in certain cases by ties extending entirely across the docks. The face of each dock is protected by wooden fender-piles, 8 ft. apart.[28]

The lozenge-shaped bulkheads appear to have been unique among early reinforced concrete dock work. While the concrete piers met expectations, they still required periodic maintenance and repair. Fenders and waling pieces which absorbed the shocks of collisions were particularly vulnerable and required repair and replacement as early as 1912.[29]

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[28]Taft, p. 1082.
[29]*Report of Harbor Board for 1912*, p. 29.

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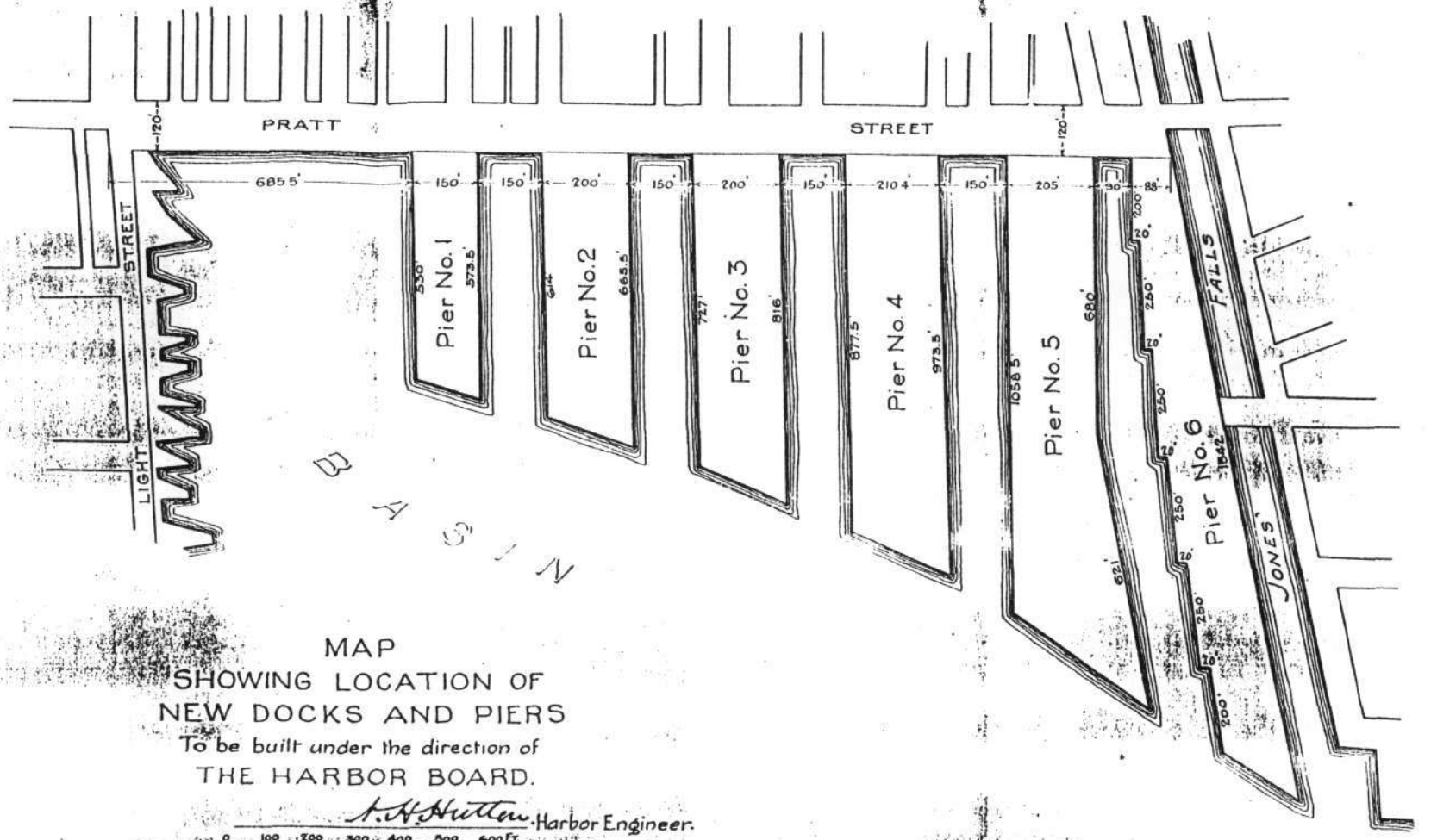
Piers 5 and 6
Baltimore City
Map from Harbor Board Annual Report for 1904



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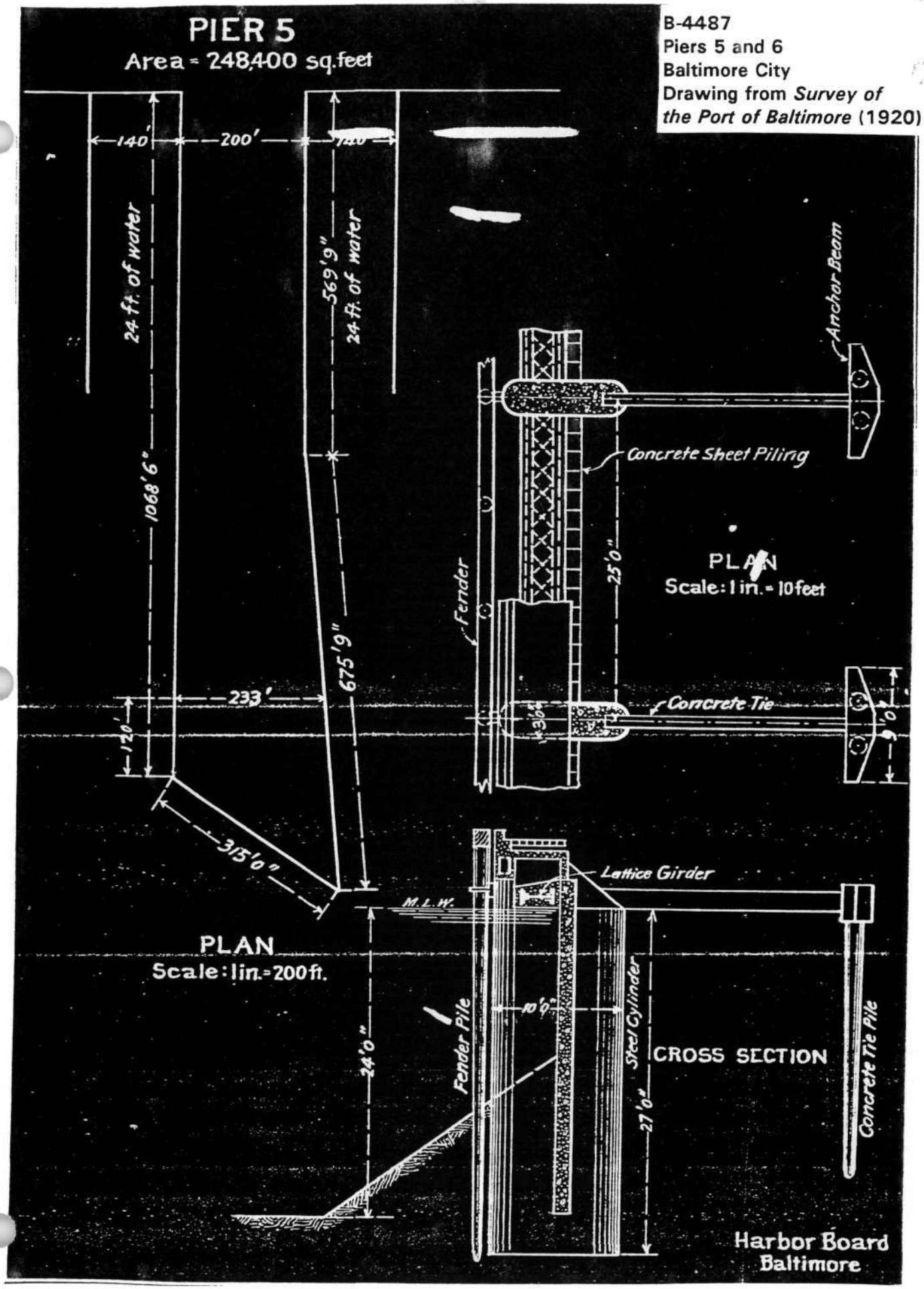
Piers 5 and 6
Baltimore City
Drawing from *Survey of the Port of Baltimore* (1920)



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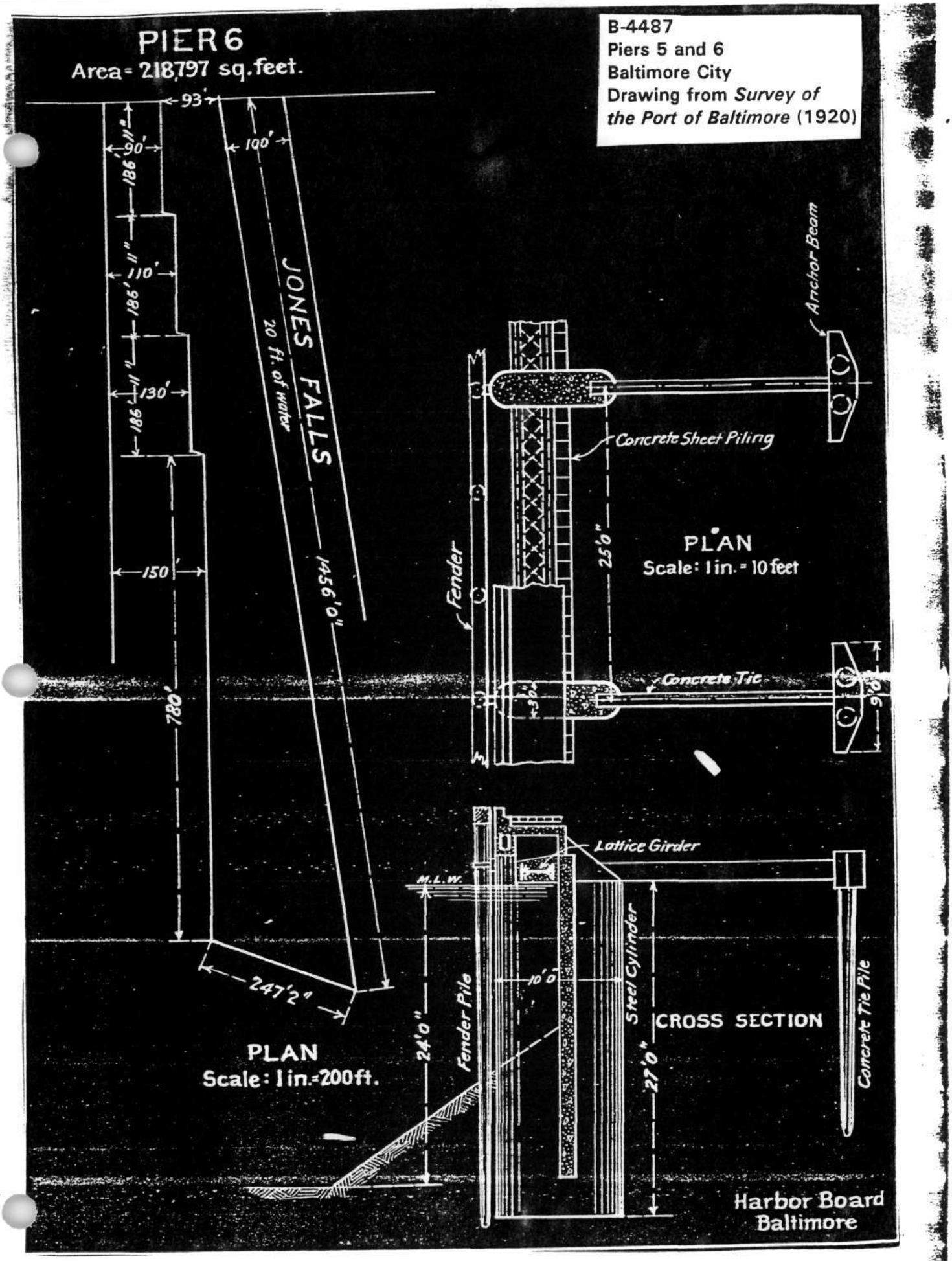
Piers 5 and 6
Baltimore City
Drawing from *Survey of the Port of Baltimore* (1920)



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B-4487
Pie[illegible]5 and 6
Ba[illegible]more City
Baltimore East, Maryland

(RELAY)
5662 II NW

Mapped by the Army Map Service
Edited and published by the Geological Survey

Control by USGS, USC&GS, USCE, and City of Baltimore

Topography from aerial photographs by photogrammetric methods. Aerial photographs taken 1943. Field checked 1944
Culture revised by the Geological Survey 1953

Hydrography compiled from USC&GS Chart 545 (1951)

Polyconic projection. 1927 North American datum
10,000-foot grid based on Maryland coordinate system
1000-meter Universal Transverse Mercator grid ticks, zone 18, shown in blue

Red tint indicates areas in which only landmark buildings are shown

Revisions shown in purple compiled by Geological Survey from aerial photographs taken 1966 and 1974. This information not field checked

Purple tint indicates extension of urban areas

MN GN

8½° / 151 MILS 0°59' / 18 MILS

UTM GRID AND 1974 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

B-4487

PIERS 5 AND 6

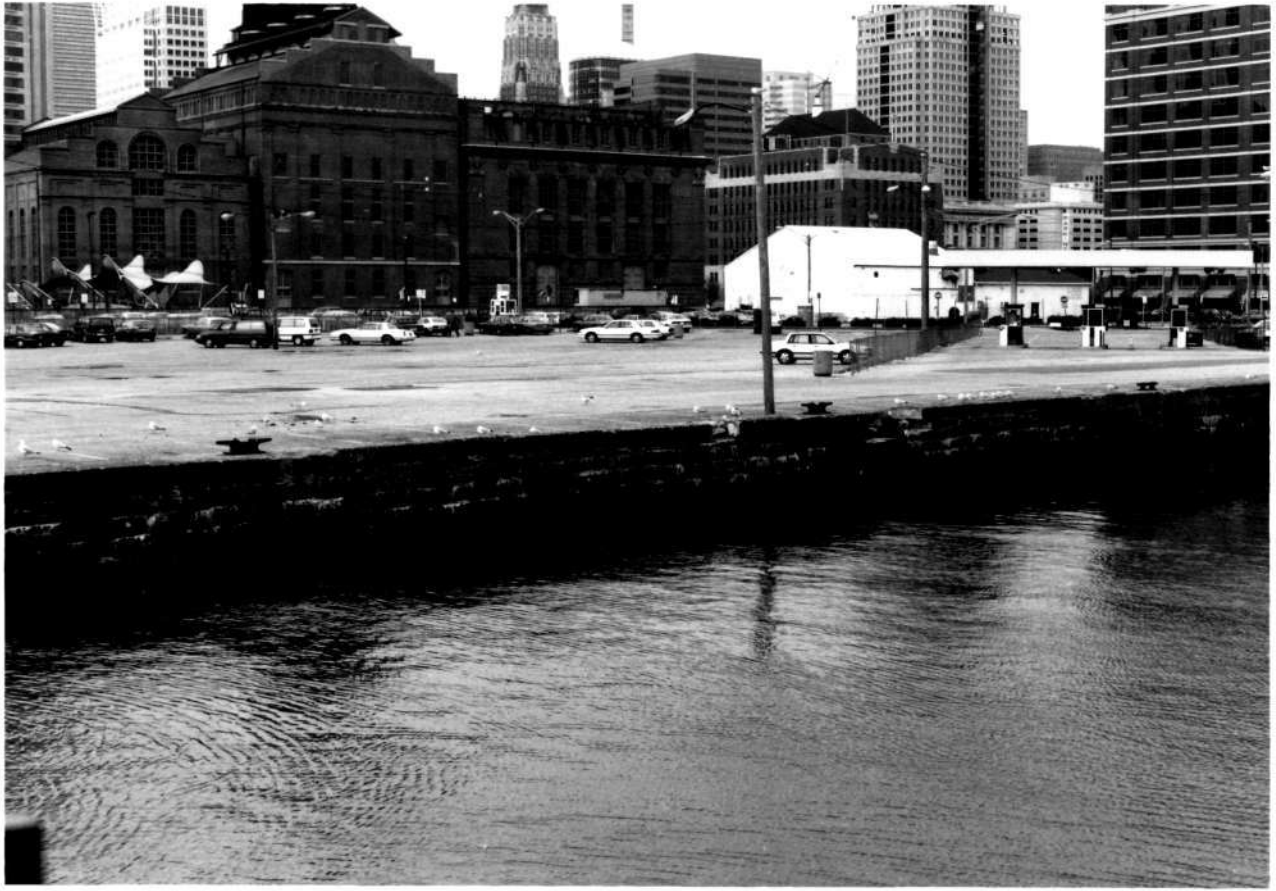
BALTIMORE CITY, MARYLAND

BETTY BIRD

FEBRUARY 27, 1992

MARYLAND SHPO

RECONSTRUCTED BULKHEAD & NEW CONSTRUCTION AT FOOT (SOUTH) OF PIER 5



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5

PIERS 5 AND 6

BALTIMORE CITY, MARYLAND

BETTY BIRD

FEBRUARY 27, 1992

MARYLAND SHPO

GRANITE-FACED BULKHEADS ON EAST SIDE OF PIER 6